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## Ambient recommendations in the pop-up shop

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# Ambient Recommendations in the Pop-up Shop

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## ABSTRACT

In this paper we present the design and first-stage analysis of a purposely built, smart, pop-up wine shop. Our shop learns from visitors' choices and recommends wine using collaborative filtering and ambient feedback displays integrated into its furniture. Our ambient recommender system was tested in a controlled laboratory environment. We report on the qualitative feedback and between subjects study, testing the influence the system had in wine choice behavior. Participants reported the system helpful, and results from our empirical analysis suggest it influenced buying behavior.

## Author Keywords

Social information filtering, Ambient computing.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## General Terms

Experimentation, Human Factors.

## INTRODUCTION

At the centre of the original ubiquitous computing vision [25] lays the idea of ubiquitous access to digital information with low cognitive demand. Despite many years of research in ubiquitous computing the majority of sources of information present in our everyday environments remain analogue, static, and disconnected from information networks. This highlights the need for new interaction models, frameworks and patterns that enable us to design new interfaces to access digital information integrated into our physical environment and with low cognitive demand.

The aim of the work presented in this paper is to design intelligent information services that support decision making in a retail environment. Our approach builds from previous work on social information filtering [21] and social navigation [4], implicit human computer interaction [10], and ambient information displays [26]. We have previously termed our approach *Hinteractions* [6].

Unlike interaction with desktop and mobile computers, the model of interaction in everyday, smart environments is not based on metaphor, but dictated by our perception of reality. We acquire information both explicitly and implicitly from our immediate surroundings. Our perception of the world is shaped by the physical and socially constructed environment [7] that emerges as a result of individuals interacting with each other in a space. The presence or absence of human activity – or social proof [2] – often affects our behavior.

The systematic collection and display of social proof, to guide decision making, is often found on online retailers. These are known as collaborative filtering recommender systems [5], and aim to harness the “wisdom of the crowds” [24] to guide purchasing behavior.

In public spaces we often use the behavior of others as a proxy for our own actions. Our engagement with others can happen implicitly or explicitly. Implicit social decision making processes [23] such as social proof [2] provide a useful model of interaction with smart, complex, information – the behavior of others – with low cognitive demand.

*Hinteractions* aims to turn implicit cues, in the behavior of others in public space, into explicit information and making this information accessible in the environment. This is analogous to “desire paths” on the grass or popcorn laying in the floor of the cinema as we leave [2]. *Hinteractions* enables us to harness the “wisdom of the crowd” to facilitate decision making in physical environments.

## RELATED WORK

### Augmenting the shopping experience

There have been a number of attempts to augment the shopping experience in retail spaces using ubiquitous computing technologies. Much of this work centers on mobile computing platforms. The advantages mobile computing provides are clear: their pervasiveness and maturity as a platform enables devices to tap into a wide array of services. Examples of successful commercial

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implementations include Google shopper [9] and RedLaser [16]. These enable users to scan a barcode, and look for further information, compare prices, read location-based reviews.

Research on Mobile Recommender Agents or (MRAs) studies ways to augment the shopping experience combining mobile technologies with recommender systems [27]. iGrocer [22] is a mobile shopping assistant aimed to help individuals build nutrition profiles and support them with personalized recommendations of products. Other mobile recommenders include EasiShop, [12] a context-sensitive uCommerce system, and APriori, [17] a product recommendation and rating system that interacts with tagged products through Near Field Communications (NFC).

The shortcomings of mobile computing are also well understood [20]: the lack of signal in some indoor environments isolating devices from the network is a clear drawback. From an interaction perspective, the size of the screen, added effort of typing to search or scan each item, having to scroll to see further information are examples of the usability issues of mobile devices.

Other projects have explored more tangible models of interaction using technologies such as RFID and portable LCD screens to augment the shopping experience. MyGROCER [13] looked at different aspects of the shopping experience and developed interventions for different scenarios. These include an in-store, smart shopping cart with an attached LCD and RFID scanner that updates a shopping list based on cart contents, a mobile application to edit shopping lists on the go, and an in-home system using RFID to detect when food runs out. The Context-Aware Shopping Trolley (CAST) [1] implemented interactive guides to direct shoppers inside supermarkets helping them find groceries. IRL SmartCart [11] is an instrumented shopping cart that uses RFID to detect location inside a supermarket and items placed in the cart providing information via an LCD attached to the trolley. Smart shelves [3], that allow tracking customer behavior in retail stores, have also been developed to understand choice patterns in retail environments.

There are also a number of projects, under the ambient intelligence paradigm, augmenting the retail experience using ambient screens. Two of these, in particular, explore the use of ambient screens to provide information on customer activity [15, 19]. We find no record in the literature of empirical studies of Ambient Recommender Systems. González [8] proposed an application of a framework for the development of Smart User Models (SUMs). A prototype application of a recommender system based on SUMs to aid firefighters decision making based on physiological data is described by the wearIT@work [14] EU funded project. Von Reischach [18] described the design space and opportunity present in the development of ubiquitous computing recommender systems but confirms that no actual implementations, as yet, exist in practice.

## THE POP-UP SHOP

Our experiment took place on a purpose-designed and built pop-up shop. The flexible and temporary nature of pop-up retail allowed us to create a plausible retail environment in a laboratory. Our choice of wine began with the observation that, for many, buying wine is a fairly familiar and regular task (unlike choosing a one-off item like a television). While being a repeated task, it is still generally a considered choice (unlike the selection of bread or milk which is largely driven by habit). In addition, wine cannot be immediately appreciated and, as such, the influence of any recommendation would be more visible.

The main physical element, designed for the shop, were six 850x850x700mm wood tables (fig 1). The top of the tables were made of 40% translucent, white Perspex®. Each table had an XBee networked Arduino processor controlling 16 uniquely addressable RGB LEDs. The LEDs projected light from inside the table, reflecting the ranking of each bottle, and creating a coaster of colored light that indicated the popularity status of each bottle in the shop. The 12 cm circle of colored light made each bottle's state very visible from all angles.

The 7mx6m laboratory environment was transformed to emulate a retail experience. Half of the 96 bottles were white and the other half red wine. The tables were arranged in three rows of two, the layout reflected a price scale, of low, medium and highly priced wine. After a period of prototyping, three colors were selected to indicate the state of each bottle, magenta, green and blue a fourth state of "off" was used for wine that had no preference data.

People's wine choices were recorded at the end of each day. Our software calculated the popularity ranking of each bottle using an item-based collaborative filtering algorithm, using Pearson correlation as a distance metric. The ranking was normalized and translated into one of the four color values. The top 33% Magenta, the next 33% Green, and the final set Blue, the lights under bottles with no data were turned off. Each bottle had a random number that uniquely identified it, printed onto a white label held by a small piece of string hanging around the bottle's neck. On the reverse of the label, there was a printed a barcode. Visitors' to the shop could pick up a bottle and scan the label to get related recommendations.

## EVALUATION

Our experiment was structured in three phases, and took place over a five-week period.

(I) Phase one was the null case, which consisted of the random assignment of magenta, green, blue and "off" to the light under each bottle in the shop. Participants were told lights were a design feature and had no meaning.

(II) Phase two was the filtering case, light colors in the shop reflected people's choices. The lights in the shop reflected popularity up to the previous day. Participants were informed of the meaning of each color via two posters hung on the walls.

(III) The third phase was the related recommendations case; lights reflected popularity, as in the second case. Additionally participants had the option to scan the label on each bottle to get further recommendations related to their choice. Upon scanning a bottle, the system would calculate a choice similarity ranking between the scanned bottle and all other items in the shop and highlight the top three closest matches in real-time.

Participants were recruited from the population of a university, 121 participants took part in either one, two or all phases of the experiment. Participants were rewarded by opting-in into a lottery to win a bottle of randomly selected wine from the shop's stock.

Participants were asked to select wine according to their usual preferences, and were given up to three 'credits' to buy wine. Three price brackets reflected the cost of wine; bottles on the first, second and third brackets cost one, two or three 'credits' respectively. Three credits allowed participants to buy either one expensive bottle, a single mid-range plus one inexpensive, or three inexpensive bottles. Bottles were moved daily to avoid the effect of location on choice. Upon arrival, each participant was informed about the nature of the experiment and asked to sign a consent form. An experimenter was available for questions but not present in the space. On completion of the selection participants filled in a short questionnaire.

We report on the qualitative responses to the system captured via our survey from participants who where exposed to the system's functionality (cases II and III) N=97, 47 male, 50 female, average age 34.6 SD=12. We also report on the observed effect related recommendations (case III) had in wine choice. Discussing the difference in observed behavior from participants who attended the first or last case but didn't attend both cases (case I or III) N=55, 33 male, 22 female, average age 34.7 SD=12.7.

## RESULTS

The overall reaction to the system was very positive. The average score, across responses, evaluating the experience was 3.8 in a five point Likert scale, where one indicated 'Terrible' and five indicated 'Wonderful'. The perceived usability of the system was also very high. In a five point Difficult-Easy scale, 85% of participants rated the system 4 or higher. In a Confusing-Clear scale 79.7% of respondents rated the presentation of information 4 or higher. When asked to rate how participants found the color-cues, 75.28% rated it 4 or higher in a 5 point Confusing-Clear scale.

When rating how helpful participants found the system, 61.62% rated it 4 or higher in an Unhelpful-Helpful scale only 4.6% rated it 'Unhelpful'. In the related recommendation phase (phase III), people provided more comments about the system and its usefulness. Since scanning a bottle triggered a recommendation related to their initial choice, the system was deemed much more useful, and personalized.



Figure 1. Pop-up wine shop with intelligent tables.

We expected that one effect of the recommender would be indicated by a shift in the distribution of wine choice against particular colors. A chi-square test on the observed frequencies of purchase per color against the colors displayed by the system. For the null phase (I) the  $\chi^2$  of the bottle choice against the lighting color was  $p=0.73$  suggesting that the lighting color had no significant influence on wine choice for the 22 participants of this phase. For the related recommendation phase (III) the chi-square test resulted in a  $\chi^2 p < 0.001$  suggesting that there was a statistically significant relationship between popularity-color and the wine eventually selected. Out of 55 bottles selected by the participants 34.8% of the wine chosen was ranked highly by the system. Furthermore only items highly ranked by the system exceeded their expected probability to be chosen, Magenta 5.4% (1.04% expected), Green 29.2% (10.4% expected). In contrast bottles ranked as being less popular did not reach their expected probability, Blue 52.7% (65.1% expected), None 12.7% (23.44% expected).

## CONCLUSION

In this paper we have presented an implementation and evaluation of an ambient recommender system. The purpose of our experiment was to aid decision-making, with a low cognitive demand, in a simulated retail environment. The outcome of our research indicates that people had a very positive reaction to the system and suggests our ambient recommender system had an effect on participants' wine choice behavior.

These results highlight that ambient feedback systems have potential to bring complex information successfully into our immediate surroundings. Compared to mobile systems, individuals don't need to invest any time installing an app, searching etc... to benefit from the system.

In our experiment, participants were exposed to 96 discrete data points with a possible 4 different states for each. Participants had no problems with understanding this information. Their feedback indicates that the vast majority could read and understand the information correctly with

little or no effort on their part. Furthermore, since the system had an observable effect on behavior, the results indicate that participants could not only understand the information presented but that they could easily apply it to their own decision making.

The results also highlight how we can bring knowledge we have about the social world, that has successfully been applied to interactions with online systems, into the design of physical interactions in the real world. HINTERactions helps augment social cognition processes with digital information to aid everyday decision making.

Finally, it is concluded that with this laboratory grounding further studies should now be performed *ex vitro*. Research in the area of ambient ubiquitous recommender systems is in very early stages and we believe our work highlights the potential of a very exciting area of ubiquitous computing research.

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## **RE-SUBMISSION CHANGE LIST**

Following comments from the program committee we have re-submitted the paper taking into account your feedback. In particular the changes implemented are:

1. Changed paper length to 4 pages.
2. Changed title to closely match the contribution.
3. Re-written related work section. The rewrite de-emphasizes the theoretical aspects of the work and introduces a literature review of work augmenting retail environments in ubicomp.
4. We have also included in our conclusions the limitations of the study and plans for future work.

Thank you for your comments, we hope you find these changes incorporate satisfactorily your feedback.